Claims:

1. A process for producing a polymeric hydrogel having a network containing macropores and micropores comprising:

(a) forming a mixture by adding at least one monomer having at least one double bond, at least one crosslinker having at least two double bonds, an initiation system, and an organic additive to form a hydro-organic system with water; and

(b) allowing the monomer and crosslinker to copolymerize to form a hydrogel having a polymeric network containing macropores and micropores.

2. The process according to claim 1 wherein the monomer having at least one double bond is selected from the group consisting of polyol esters of acrylic acid, polyol esters of methacrylic acid, and mixtures thereof.

3. The process according to claim 1 wherein the monomer having at least one double bond is one or more hydrophilic monomers of polyol esters of acrylic or methacrylic acid.

4. The process according to claim 2 or 3 wherein the polyol is selected from the group consisting of polyethylene glycol, polyethylene glycol esters or ethers, polypropylene glycol, polypropylene glycol esters or ethers, random or block copolymers of ethylene glycol and propylene glycol, glycerol, pentaerythritol, ethylene glycol, propylene glycol, and mixtures thereof.

5. The process according to any one of claims 1 to 4 wherein the monomer is hydroxyethyl methacrylate (HEMA).

6. The process according to any one of claims 1 to 5 wherein the monomer is used at a concentration from 5 to 50%.

7. The process according to any one of claims 1 to 6 wherein the crosslinker having at least two double bond is selected from the group consisting of esters of acrylic and/or methacrylic acid, acrylic or methacrylic acid with various polyols, and mixtures thereof.

8. The process according to claim 7 wherein the polyol is selected from the group consisting of polyethylene glycol, polypropylene glycol, random or block copolymers of ethylene glycol and propylene glycol, glycerol, pentaerythritol, ethylene glycol, propylene glycol, and mixtures thereof.

9. The process according to any one of claims 1 to 8 wherein the crosslinker is ethylene glycol dimethacrylate (EGDMA).

10. The process according to any one of claims 1 to 9 wherein the crosslinker is used at a concentration of greater than about 50% in the mixture of crosslinkers; more preferably greater than about 80%.

11. The process according to any one of claim 1 to 10 wherein the polymeric hydrogel is made from a mixture of monomer content of about 10 to 40%M and crosslinker of about 1 to 30%X before polymerization.

12. The process according to claim 11, utilizing HEMA with EGDMA wherein compositions of monomer mixture of HEMA with EGDMA are less than about 40% M and less than about 20% X.

13. The process according to any one of claims 1 to 12 wherein a free radical producing method is used as initiation system.

14. The process according to claim 13 wherein the initiation system is formed by redox, thermal or photo initiators.

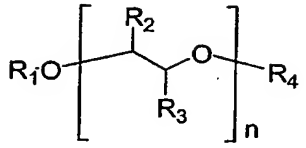
15. The process according to claim 14 wherein the redox initiator is formed by ammonium persulphate (APS) with *N,N,N',N'*-tetramethylethylenediamine (TEMED).

16. The process according to any one of claims 1 to 15 wherein the organic additive is a hydrophilic polymer miscible with water and miscible with a linear polymer produced from the monomer used for copolymerization, or a hydrophilic polymer miscible with water and having a similar solubility parameter ($\pm 10(MPa)^{0.5}$) to that of a polymer produced from the monomer used for copolymerization.

17. The process according to claim 16 wherein the organic additive is single entity acting as both a porogen to form macropores during the polymerization and a solvent with water to form the hydro-organic solvent.

18. The process according to claim 17 wherein the organic additive is selected from the group consisting of ethylene glycol, polyethylene glycol, propylene glycol, polypropylene glycol, random or block copolymers of ethylene glycol, random or block copolymers of polyethylene glycol, random or block copolymers of propylene glycol, random or block copolymers of polypropylene glycol, ethylene glycol having an ester or ether end group, polyethylene glycol having an ester or ether end group, propylene glycol having an ester or ether end group, polypropylene glycol having an ester or ether end group, and mixtures thereof.

19. The process according to claim 18 wherein the organic additive has the following general formulation:



R_1, R_4 = H, CH_3, $-(CH_2)_X-CH_3$ (x=1-4),
$-C(=O)-R_5$ ($R_5=(CH_2)_X-CH_3$ (x=0-4))

R_2, R_3 = H, CH_3, $-(CH_2)_X-CH_3$ (x=1-4), OH

20. The process according to claim 19 wherein the organic additive is a polyethylene glycol or polypropylene glycol.

21. The process according to claim 20 wherein the polyethylene glycol has a molecular weight range from 100 to 100000; preferably from 200 to 10000; and more preferably from 400 to 4000.

22. The process according to claim 20 wherein the polypropylene glycol has a molecular weight range from 100 to 100000; preferably from 200 to 10000; and more preferably from 58 to 600.

23. The process according to claim 16 wherein the organic additive is a copolymer with a hydrophilic component and a hydrophobic component.

24. The process according to claim 23 wherein the organic additive is a copolymer of polyethylene glycol with polypropylene glycol.

25. A polymeric hydrogel having a network containing macropores and micropores produced by the process according to any one of claims 1 to 24.

26. A polymeric hydrogel comprising a network of macropores and micropores formed by copolymerizing at least one monomer having at least one double bond and at least one crosslinker having at least two double bonds in the presence of a organic additive forming a hydro-organic system with water.

27. The hydrogel according to claim 26 wherein the monomer having at least one double bond is selected from the group consisting of polyol esters of acrylic acid, polyol esters of methacrylic acid, and mixtures thereof..

28. The hydrogel according to claim 26 wherein the monomer having at least one double bond is one or more hydrophilic monomers from the polyol esters of acrylic or methacrylic acid.

29. The hydrogel according to claim 27 or 28 wherein the polyol is selected from the group consisting of polyethylene glycol, polyethylene glycol esters or ethers, polypropylene glycol, polypropylene glycol esters or ethers, random or block copolymers of ethylene glycol and propylene glycol, glycerol, pentaerythritol, ethylene glycol, propylene glycol, and mixtures thereof.

30. The hydrogel according to any one of claims 26 to 29 wherein the monomer is hydroxyethyl methacrylate (HEMA).

31. The hydrogel according to any one of claims 26 to 30 wherein the monomer is used at a concentration from 5 to 50%.

32. The hydrogel according to any one of claims 26 to 31 wherein the crosslinker having at least two double bond is selected from the group consisting of esters of acrylic and/or methacrylic acid, acrylic or methacrylic acid with various polyols, and mixtures thereof.

33. The hydrogel according to claim 32 wherein the polyol is selected from the group consisting of polyethylene glycol, polypropylene glycol, random or block copolymers of ethylene glycol and propylene glycol, glycerol, pentaerythritol, and ethylene glycol, propylene glycol which are fully or partly esterified, and mixtures thereof.

34. The hydrogel according to any one of claims 26 to 33 wherein the crosslinker is ethylene glycol dimethacrylate (EGDMA).

35. The hydrogel according to any one of claims 26 to 34 wherein the crosslinker is used at greater than about 50% in the mixture of crosslinkers; more preferably greater than about 80%.

36. The hydrogel according to any one of claim 26 to 35 wherein the polymeric hydrogel is made from a mixture of monomer content of 10 to 40%M and crosslinker of 1 to 30%X before polymerization.

37. The hydrogel according to claim 36, wherein compositions of monomer mixture of HEMA with EGDMA are less than about 40% M and less than about 20% X.

38. The hydrogel according to any one of claims 26 to 37 wherein a free radical producing method is used as initiation system.

39. The hydrogel according to claim 38 wherein the initiation system is formed by redox, thermal or photo initiators.

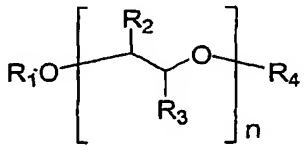
40. The hydrogel according to claim 39 wherein the redox initiator is formed by ammonium persulphate (APS) with *N,N,N',N'*-tetramethylethylenediamine (TEMED).

41. The hydrogel according to any one of claims 26 to 40 wherein the organic additive is a hydrophilic polymer miscible with water and miscible with a linear polymer produced from the monomer used for copolymerization; or a hydrophilic polymer miscible with water and has a similar solubility parameter ($\pm 10(MPa)^{0.5}$) to that of a polymer produced from the monomer used for copolymerization.

42. The hydrogel according to claim 41 wherein the organic additive is single entity acting as both a porogen to form macropores during the polymerization and a solvent with water to form the hydro-organic solvent.

43. The hydrogel according to claim 42 wherein the organic additive is selected from the group consisting of ethylene glycol, polyethylene glycol, propylene glycol, polypropylene glycol, random or block copolymers of ethylene glycol, random or block copolymers of polyethylene glycol, random or block copolymers of propylene glycol, random or block copolymers of polypropylene glycol, ethylene glycol having an ester or ether end group, polyethylene glycol having an ester or ether end group, propylene glycol having an ester or ether end group, polypropylene glycol having an ester or ether end group, and mixtures thereof.

44. The hydrogel according to claim 43 wherein the organic additive has the following general formulation:



R_1, R_4 = H, CH_3, $-(CH_2)_X-CH_3$ (x=1-4),
$-C(=O)-R_5$ ($R_5=(CH_2)_X-CH_3$ (x=0-4))

R_2, R_3 = H, CH_3, $-(CH_2)_X-CH_3$ (x=1-4), OH

45. The hydrogel according to claim 44 wherein the organic additive is a polyethylene glycol or polypropylene glycol.

46. The hydrogel according to claim 45 wherein the polyethylene glycol has a molecular weight range from 100 to 100000; preferably from about 200 to 10000; and more preferably from about 400 to 4000.

47. The hydrogel according to claim 45 wherein the polypropylene glycol has a molecular weight range from 100 to 100000; preferably from 200 to 10000; and more preferably from 58 to 600.

48. The hydrogel according to claim 41 wherein the organic additive is a copolymer with a hydrophilic component and a hydrophobic component.

49. The hydrogel according to claim 48 wherein the organic additive is a copolymer of polyethylene glycol with polypropylene glycol.

50. The hydrogel according to any one of claims 26 to 49 being visually clear.

51. A separation medium formed from the polymeric hydrogel according to claim 25 or any one of claims 26 to 50.

52. The separation medium according to claim 51 in the form of membrane, slab, bead or column.

53. The separation medium according to claim 51 being an electrophoretic medium capable of separating large biomolecules or compounds having a molecular weight of at least 2000 k.

54. A method for separating one or more compounds according to size using electrophoresis, the method comprising:

(a) providing a medium in the form of polymeric hydrogel having a network containing macropores and micropores according to claim 25 or any one of claims 26 to 50;

(b) adding one or more compounds to part of the medium; and

(c) applying an electric potential causing at least one compound to pass through the medium, wherein movement through the medium is related to the size of the compound.

55. A size exclusion electrophoresis system comprising:

(a) a cathode;

(b) an anode; and

(c) a separation medium in the form of polymeric hydrogel having a network containing macropores and micropores according to claim 25 or any one of claims 26 to

50 capable of separating a mixture of compounds according to size, the medium disposed between the anode and cathode.

56. Use of a separation medium in the form of polymeric hydrogel having a network containing macropores and micropores according to claim 25 or any one of claims 26 to 50 in size exclusion electrophoresis.